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Nonlinear and anisotropic strain in ultrafast laser-excited semiconductors ERIC LANDAHL, DePaul Univ, G. JACKSON WILLIAMS, Lawrence Livermore National Laboratory, DONALD WALKO, Argonne National Laboratory, SOOHEYONG LEE, Korea Research Institute of Standards and Science — We have used time-resolved x-ray diffraction to measure the lattice response of gallium arsenide and indium antimonide crystals following ultrafast laser absorption. Our studies use two modified approaches: measurement of multiple lattice planes and decomposition into principal axes using a strain rosette, and modulations of x-ray diffraction lineshapes by multiphoton processes. In contradiction to the common one-dimensional assumption of the Thomsen strain model (Phys. Rev. B 34, 41294138 (1986)), we find that anisotropic strain is responsible for a considerable fraction of the total lattice motion at early times in GaAs before thermal equilibrium is achieved. We also find that the initial linear expansion of the crystal stagnates at a laser fluence corresponding to the saturation of the free carrier density before resuming expansion in a third regime at higher fluences where two-photon absorption becomes dominant. We therefore claim to be able to visualize anisotropic and nonlinear optical effects directly in the dynamic structure of these materials.

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